SILICON N-P-N "overlay" TRANSISTOR

2N5102

File No. 279

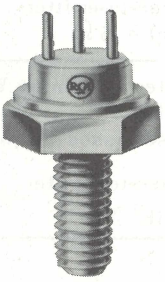
RCA-2N5102* is an epitaxial silicon n-p-n planar transistor of the "overlay" emitter electrode construction. It is especially designed with integral ballast resistors in each emitter site to provide high power as a class-C rf amplifier for VHF Aircraft Communications service (108 to 150 MHz) with amplitude modulation and 24-volt power supply.

The transistor features complete protection against any load mismatch. Each unit is tested at 118 MHz with full modulation and no current limiting for all load mismatch conditions from short-circuit to open-circuit.

In the overlay structure, there are a number of individual emitter sites which are all connected in parallel and used in conjunction with a common collector region. When compared with other structures, this arrangement provides a substantial increase in emitter periphery for higher current or power, and a corresponding decrease in emitter and collector areas for lower input and output capacitances. The overlay structure thus offers greater power output, gain efficiency, frequency capability, and linearity.

Formerly RCA-Dev. No. TA2791.

High-Power Device for Class-C, AM Operation in VHF Circuits



JEDEC TO-60

H-1307

- 15 Watts Output Min. at 136 MHz
- For 24-Volt Aircraft Communication
- Complete Load Mismatch Protection
- High Voltage Ratings
- Case Connected to Emitter

RATINGS

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-EMITTER VOLTAGE:			
With V_{BE}= − 1.5 volts	V_{CEV}	100	V
With external base-to-emitter resistance R_{BE} = 5 Ω	V_{CER}	50	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	4	V
COLLECTOR CURRENT:			
Peak		10	A
Continuous	I_C	3.3	A
TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 25° C		70	W
At case temperatures above 25° C		See Fig. 8.	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. from insulating wafer for 10 s max		230	°C

TYPICAL POWER OUTPUT vs. FREQUENCY

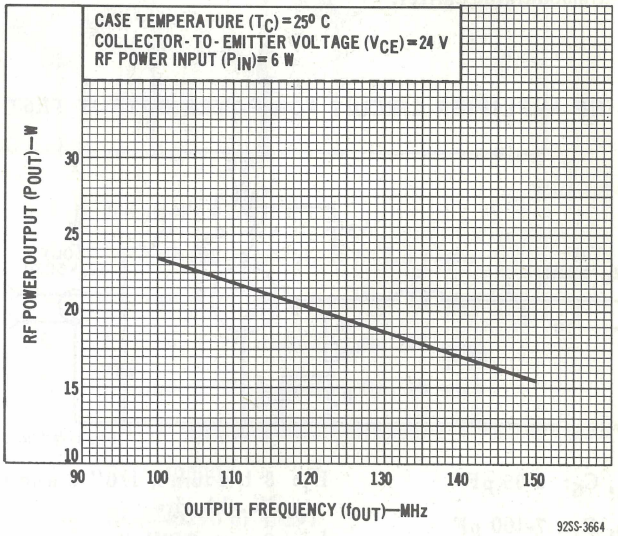


Fig. 1

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ELECTRICAL CHARACTERISTICS

Case Temperature = 25° C

Characteristic	Symbol	TEST CONDITIONS							LIMITS		Units
		DC Collector Volts		DC Base Volts	DC Current (Milliamperes)		RF Power Watts	Frequency MHz			
		V_{CB}	V_{CE}	V_{BE}	I_E	I_C	P_{IN}	f	Min.	Max.	
Collector-Cutoff Current With external base-to-emitter resistance (R_{BE}) = 5 Ω	I_{CER}		50							10	mA
Collector-to-Emitter Sustaining Voltage With base-to-emitter junction reverse biased	$V_{CEV}(sus)$			- 1.5		600[a]			100		V
With external base-to-emitter resistance (R_{BE}) = 5 Ω	$V_{CER}(sus)$					200[a]			50		V
Emitter-to-Base Breakdown Voltage	BV_{EBO}				10	0			4		V
Collector-to-Base Capacitance	C_{ob}	30				0				85	pF
RF Power Output *(See Fig. 2.)*	P_{OUT}		24 (V_{CC})				6	136	15[b]		W
Modulation[c]	M		24					118	80		%
Load Mismatch[d]	LP		24					118	Will not be[d] damaged		—
Dynamic Input Impedance *(See Fig. 2.)*	Z_{IN}		24			1,100	6	150	1.7 + j 2.6 (typ.)		Ω

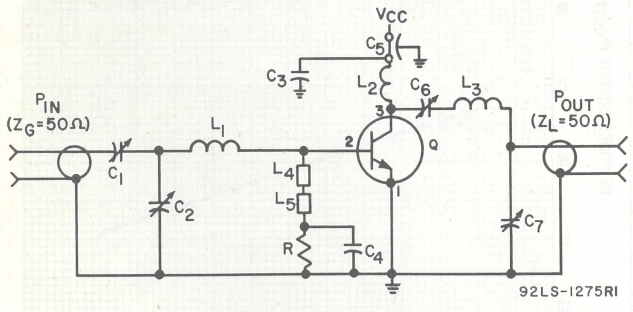
[a] Pulsed through an inductor (9 MH); duty factor = 50%.

[b] Unmodulated carrier.

[c] See Fig. 2 & 3. Carrier Power, P_{CAR}, = 15 W; V_{CC} modulation = 100%; $M = \sqrt{\frac{2\,(P_{AM} - P_{CAR})}{P_{CAR}}} \times 100\%$.

[d] Under conditions of *footnote* c, the transistor is subjected to all conditions of load mismatch from short-circuit to open-circuit.

RF AMPLIFIER CIRCUIT FOR POWER OUTPUT TEST



C_1, C_6: 3-35 pF

C_2, C_7: 7-100 pF

C_3: 0.1 μF

C_4: 0.05 μF

C_5: 1,000 pF

R: 1 Ω wire wound

L_1: 3 1/4 turns, 1/8" diameter, No. 14 wire

L_2: 2 turn, 3/8" diameter, No. 14 wire

L_3: 4 turns, 3/8" diameter, No. 14 wire

L_4, L_5: 350 Ω Ferrite choke, Ferroxcube # VK200 01-3B*

Q: 2N5102

*Ferroxcube Corp. of America Saugerties, N.Y.

Fig. 2

BLOCK DIAGRAM FOR MODULATION TEST

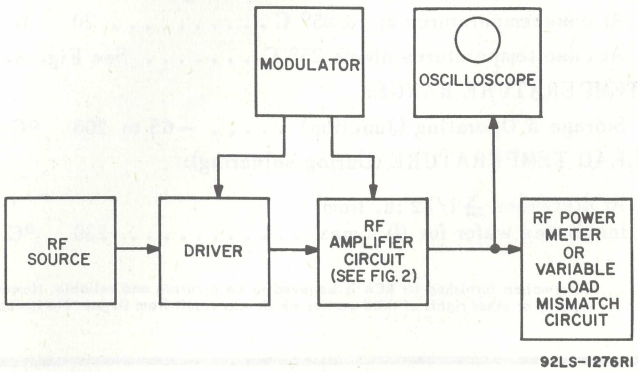


Fig. 3

TYPICAL RF POWER OUTPUT vs. COLLECTOR-TO-EMITTER VOLTAGE

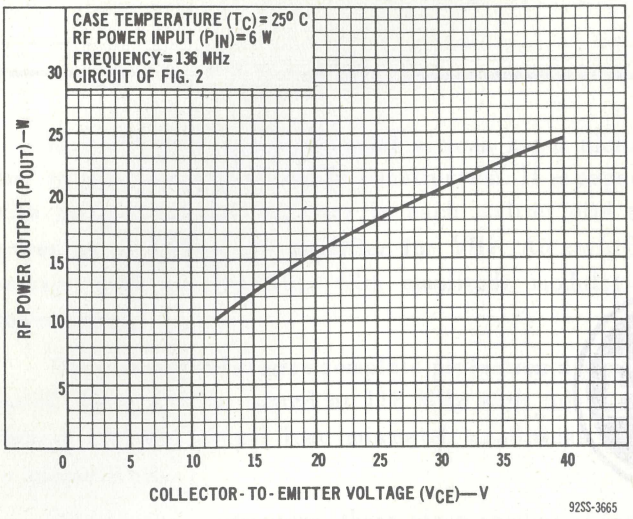


Fig. 4

TYPICAL COLLECTOR EFFICIENCY vs. FREQUENCY

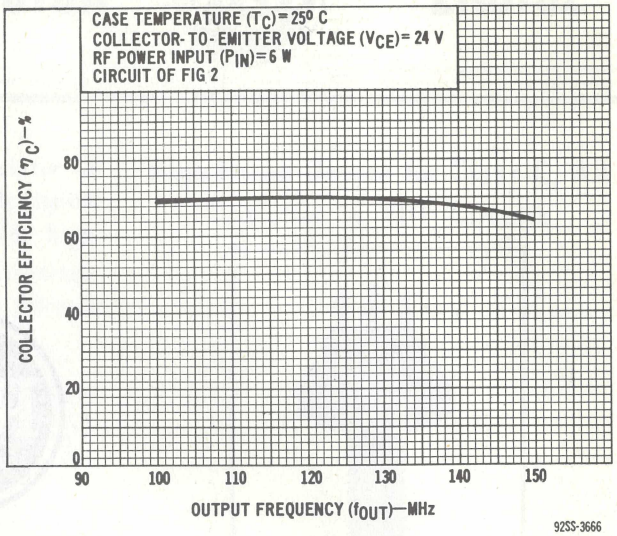


Fig. 5

TYPICAL POWER OUTPUT vs. POWER INPUT

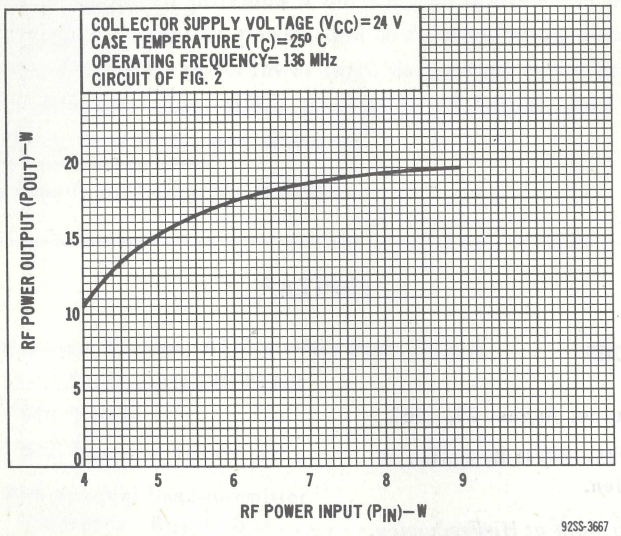


Fig. 6

TYPICAL VARIATION OF COLLECTOR-TO-BASE CAPACITANCE

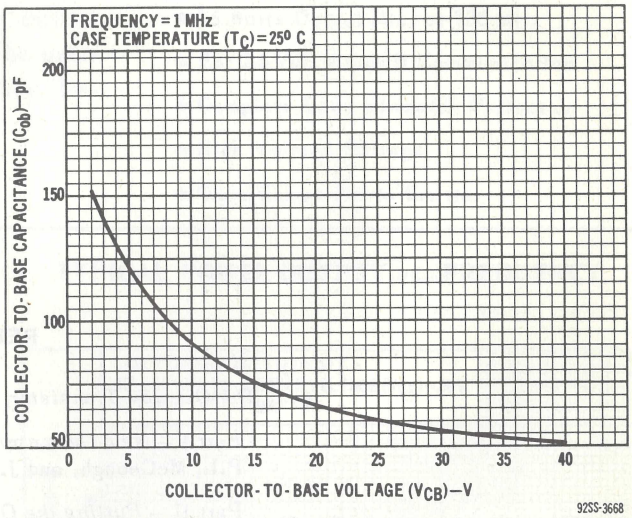


Fig. 7

DISSIPATION DERATING CURVE

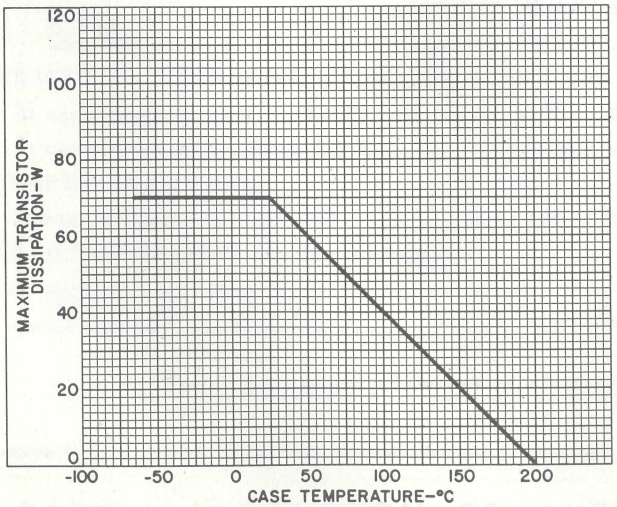


Fig. 8

SAFE OPERATION WITH DC FORWARD BIAS

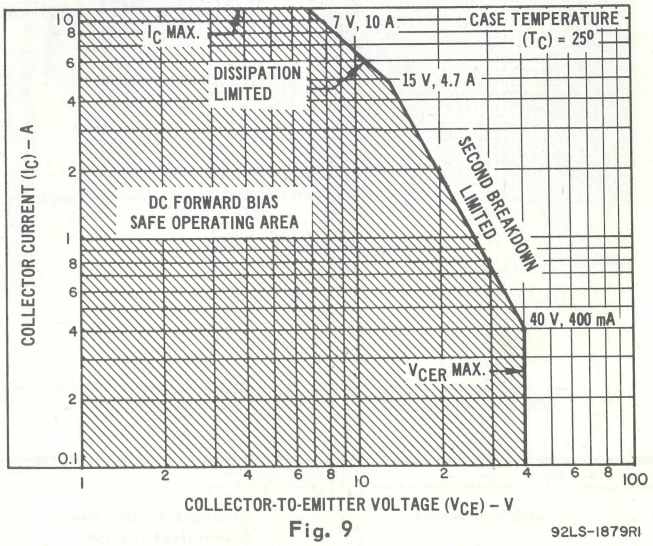
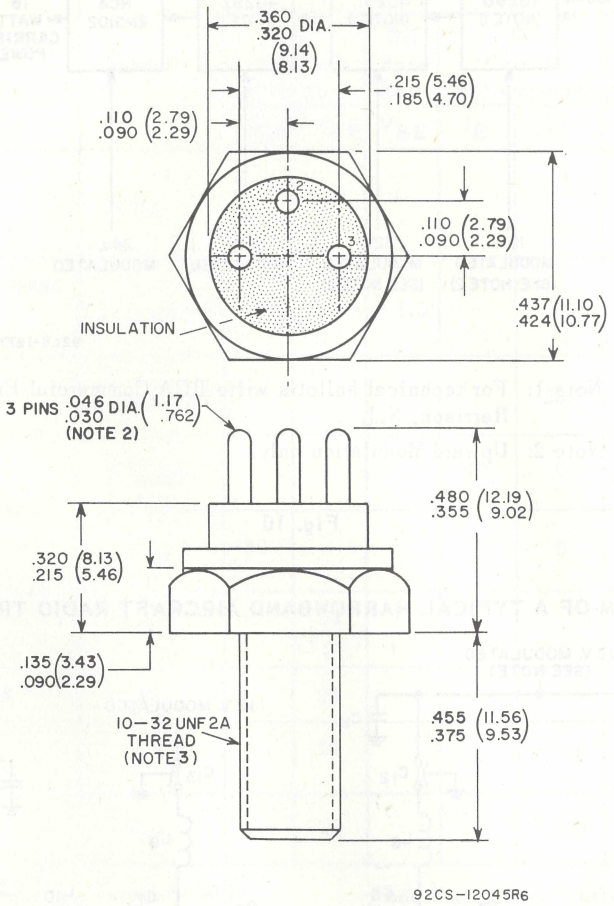


Fig. 9

DIMENSIONAL OUTLINE

JEDEC TO-60



DIMENSIONS IN INCHES AND MILLIMETERS

Note 1: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

Note 2: The pin spacing permits insertion in any socket having a pin-circle diameter of 0.200" (5.08) and contacts which will accommodate pins having a diameter of 0.030" (.762) min., .046" (1.17) max.

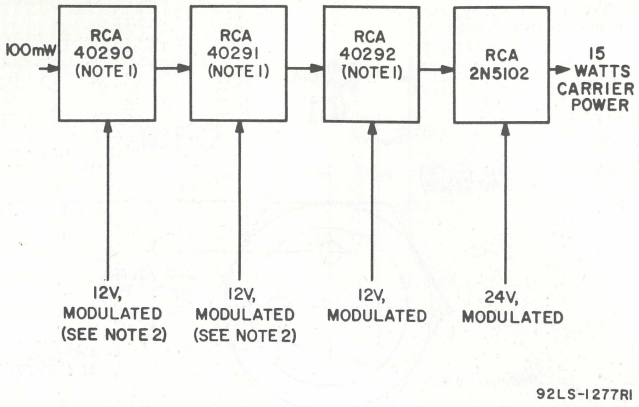
Note 3: The torque applied to a 10-32 hex nut assembled on the thread during installation should not exceed 12 inch-pounds.

Note 4: This device may be operated in any position.

TERMINAL CONNECTIONS

Mounting stud, case, Pin No. 1 - Emitter
Pin No. 2 - Base
Pin No. 3 - Collector

BLOCK DIAGRAM OF A TYPICAL NARROWBAND AIRCRAFT RADIO TRANSMITTER CHAIN

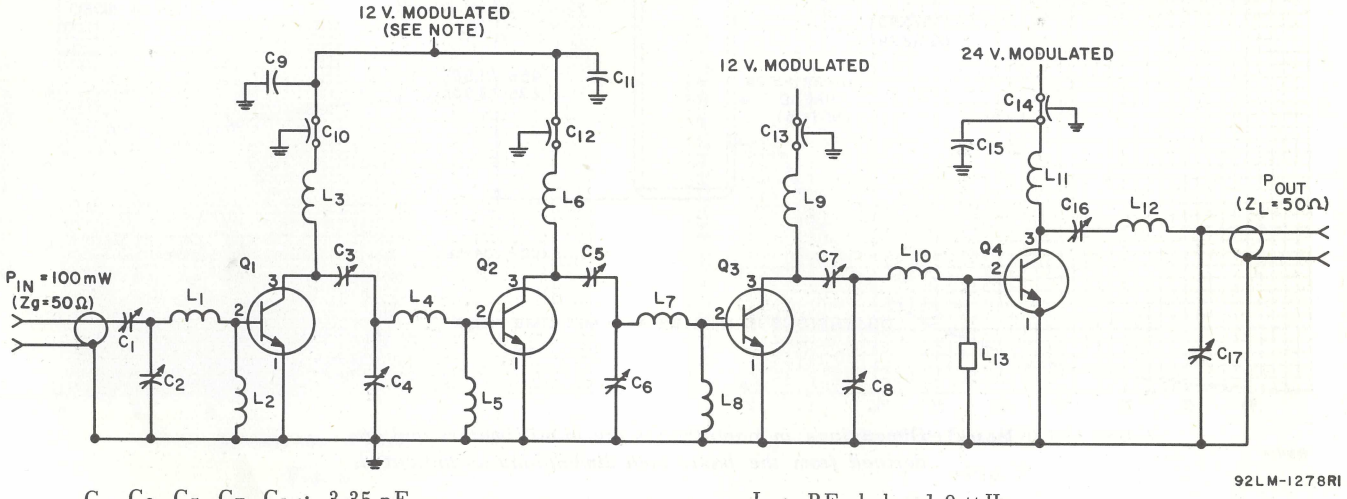


Note 1: For technical bulletin write RCA Commercial Eng., Harrison, N.J.

Note 2: Upward Modulation only.

Fig. 10

CIRCUIT DIAGRAM OF A TYPICAL NARROWBAND AIRCRAFT RADIO TRANSMITTER CHAIN



C_1, C_3, C_5, C_7, C_{16}: 3-35 pF

C_2, C_4, C_6, C_8, C_{17}: 8-60 pF

C_9, C_{11}, C_{13}: 0.03 μF

C_{10}, C_{12}, C_{14}: 1,000 pF

C_{15}: 0.1 μF

L_1, L_9: 3 turns, 1/4" diameter, No. 16 wire

L_2, L_5: Ferrite choke, Z = 450 ohms, Ferroxcube # VK200 01-4B*

L_3: RF choke, 1.5 μH

L_4, L_7: 4 turns, 1/4" diameter, No. 16 wire

L_6: RF choke, 1.0 μH

L_8: wire wound resistor, R = 2.4 ohms

L_{10}: 3 turns, 1/8" diameter, No. 14 wire

L_{11}: 2 turns, 1/2" diameter, No. 16 wire

L_{12}: 4 turns, 1/2" diameter, No. 16 wire

L_{13}: 350 Ω ferrite choke, Ferroxcube # VK200 01-3B*

Q_1: RCA-40290

Q_2: RCA-40290 or 40291

Q_3: RCA-40292

Q_4: 2N5102

Note: Upward modulation only.

*Ferroxcube Corp. of America Saugerties, N.Y.

Fig. 11

REFERENCES

1. *The Overlay Transistor,* Electronics, August 23, 1965.

Part I – *New Geometry Boosts Power,* D.R. Carley, P.L. McGeough, and J.F. O'Brien.

Part II – *Putting the Overlay to Work at Hi-Frequency,* Dr. D.J. Donahue and B.A. Jacoby.

2. *Design of Large-Signal VHF Transistor Power Amplifier,* R. Minton, RCA Application Note SMA-36.